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SCIENCE AND TECHNOLOGY[1]

By Professor ERNEST O. LAWRENCE
UNIVERSITY OF CALIFORNIA

IT is appropriate on this occasion to draw your attention again to the great partnership of modern times—science and technology; for the mutual dependence of the pure and applied sciences in the development of our material welfare is nothing short of an absorbing romance.

The applied sciences are devoted to perfecting instruments and means already available, a procedure which in some quarters has been regarded as the best attack on practical problems. On the other hand, the pure scientist is guided by curiosity to learn more about the facts of nature—and it frequently has turned out that new knowledge thus gained has furnished the basis for doing something in a way incomparably better than any perfection of the methods that were already in use.

The following is an illustration: A hundred years ago if one had wanted to improve artificial illumination the direct practical procedure would have been to improve the candle or the oil lamp, and worthwhile progress could certainly have been made in this direction; but researchers in electricity, who studied the subject at that time entirely without regard to its practical application, furnished the basis for new means of lighting which turned out to be vastly superior to anything that could have been obtained by the further perfection of the old sources. It was then that Michael Faraday discovered that a current can be generated in a wire by a changing magnetic field. You all know how, from the tiny galvanometer deflection which first showed Faraday the principle of electromagnetic induction, there developed for the use and comfort of mankind the electric generator, the electric light and the hosts of modern inventions which have followed in their wake.

It is remarkable that Faraday, the man of science so

[1] Commencement address at the Stevens Institute of Technology, on June 12, 1937.

devoted to the patient search for the underlying principles of electricity, possessed at the same time a vivid appreciation of the practical implications of scientific discoveries. Gladstone, you will remember, on seeing one of Faraday's famous experiments terminate in an effect which to the non-scientific mind was very uninspiring, asked what possible use his discovery could be. "Why, Mr. Prime Minister," answered Faraday, "you will soon be able to tax it." On another occasion in reply to a similar question from an elderly lady, he quoted Benjamin Franklin, "Madam, of what use is a new-born child?"—a remark full of significance.

It might be argued that one should devote himself only to those subjects that can be immediately applied; but the development of some entirely new branch of science may give a means of benefiting humanity which could not have been foreseen had one been guided solely by practical considerations. Again let us take a hypothetical illustration. Suppose that in the nineties a surgeon had set himself the task of improving the methods of diagnosing and setting bone fractures. He would not have known that the greatest contribution to that problem—the discovery of x-rays—was soon to come from the quiet laboratory of a man curious about electrical phenomena in a vacuum tube.

Roentgen's discovery, closely followed by Becquerel's recognition of radioactivity, provide two of the prominent milestones of science. The benefits that have already been given to mankind through their application to medicine are familiar to all, but they were of much greater significance than in respect to their practical aspects alone. When these startling discoveries were made physical science was drifting in the doldrums. There was a wide-spread feeling that the great underlying laws of nature were fully comprehended and that the scientific developments of the future would be concerned with less interesting and important details. Michelson had just made his whimsical prognostication that the future of physics lies in the next decimal place, implying a not too exciting or brilliant prospect. But the discovery of x-rays and radioactivity abruptly altered all this by reviving science, and at the same time the proper humility of scientists.

These epoch-making discoveries suddenly disclosed a new world—the world of the atom. The chemist's conception of the atom as an indivisible entity was soon discarded and in its place came wide recognition that within the atom lie domains of inconceivable richness. It is needless to elaborate on the great strides made by atomic physics in the intervening years. The man in the street now knows that his radio is operated by innumerable tiny slaves called electrons; and over his radio comes information on other miracles of technological science which have to do with the scintillating world of atoms. This is only to remind you that all these things came in the wake of Roentgen's chance discovery.

Again history has repeated itself—there are scientific cycles just as there are business cycles. Thirty years after the discovery of x-rays, the atomic theory had acquired an unwarranted position. The great successes of the theory gave rise to a wide-spread feeling that scientists really understood the underlying principles of the atomic world and again that the future held forth only the unexciting prospect of elaborating the details. The arrogance and complacency of the atomic physicist of the last decade was a perfect repetition of the attitude of the classical physicists at the end of the last century.

This state of affairs was short-lived, for now we are on the threshold of a new era fraught with potentialities for the future, as in the days of Faraday and of Roentgen—the era of the atomic nucleus. The new frontier lies within the hearts of atoms, and we are in a position to attack the problem the ancient alchemists set for themselves. Indeed their dreams have already been surpassed, for they sought ways of turning base metal into gold, while the modern scientist is now making something vastly more precious and useful, the artificial radioactive substances. It is not possible here to adequately tell the exciting story of artificial radioactivity and the important contributions to medical science that are in prospect or to tell about those swiftly moving fragments of atoms, the neutron rays, that are often the result of explosions within the atomic nucleus, and which are more penetrating than x-rays and indeed are already known to have more interesting properties.

Even to give you a survey of the many advances in the domain of the atomic nucleus would exceed the limits of your patience, and I shall restrict myself to the discussion of one significant result that has recently emerged—the experimental proof of the equivalence of mass and energy.

One of the consequences of Einstein's theory of relativity, first enunciated in 1905, was that matter is one form of energy. This consequence of relativity that it might be possible to release energy by the annihilation of matter or that matter might be created by the absorption of energy was no more revolutionary than the fundamental postulates of the relativity theory, yet it rocked the very foundations of physical thought—for we all had been brought up on the principles of the conservation of energy and the indestructibility of matter.

As the Einstein theory grew in favor, the validity of the mass-energy relation became more apparent, but until direct experimental verification was forthcoming, Einstein's great deduction could not be regarded as an

established law of nature. Cockcroft and Walton, of the Cavendish Laboratory, in their pioneering experiments about five years ago on the transmutation of lithium were the first to observe beyond any question the conversion of matter into energy. Subsequently, studies of many other examples of transformation of the elements have given an abundance of additional evidence and there is no longer any doubt about the truth of this principle.

Now that it is an established fact that matter can be converted into energy, let us consider for a moment what this means. At the outset one is impressed with the tremendous amount of energy tied up in the form of matter. For example, a simple calculation according to the relativity theory shows that a glass of water if completely destroyed and converted into useful energy would yield more than a billion kilowatt hours, enough energy to supply a city with light and power for quite a time. It is a highly practical question therefore to inquire whether it is possible to tap this inexhaustible supply of fuel.

The source of the sun's energy has long been a great mystery, for there is good evidence that it has been blazing at its present brilliance for billions of years, and as yet there is no sign of its going out. Fuel for this almost eternal fire could be of no ordinary sort; and astronomers and physicists now believe that conditions within the sun are such that nuclear reactions are taking place on an extensive scale with the destruction of matter and conversion into radiant energy. Thus, the sun is gradually through the ages losing its mass; slowly its very substance is radiating into space.

But whether it will be possible to release subatomic energy on a practical and profitable basis for industrial purposes, whether perhaps it will be possible to realize conditions on the earth similar to those in the sun, is the question which of course interests the engineer. Indeed, it is a question of interest to every one, and accordingly it has been the subject of much popular discussion and speculation. But speculation is hardly more than a game of fortune-telling, and this is out of place here. It is only of interest to indicate the present state of knowledge with proper humility, with recognition that what the future holds forth only the future can tell. In this spirit it may be said at this time that although we now know that matter can be converted into energy, there is no greater prospect of destroying nuclear matter for power purposes than of cooling the ocean to freezing temperatures and extracting the heat for profitable work. Certain considerations bearing on the second law of thermodynamics would appear to govern the availability of energy in the hearts of atoms as in the Atlantic Ocean itself.

While the view that some day power plants may be run by the release of subatomic energy and that nuclei of atoms may be used as fuel appears fantastic, nevertheless, proof of the equivalence of mass and energy is none the less of great practical importance. It is conceivable that in our lifetime this great principle will play a vital rôle in technical developments which at the moment are beyond our dreams—for such has been the history of science.

Thus far the essential rôle played by pure science in industrial development has been dwelt upon with the endeavor to bring into relief the fact that much of our technological progress can only be achieved by the methods of the investigator whose primary interest is that of unravelling the mysteries of nature—following the threads of logic and experimental revelation wherever they lead without restriction of practical goals. But to stop here would be giving only one side of the picture; for technology is just as important for science as science is for technology.

In making this assertion the thought in mind is not that in the long run the practical achievements of industrial science are responsible for the prosecution of pure science, although it is true in large measure. Rather it is that industrial developments, per se, have been of essential importance in scientific progress.

Two famous experiments, one devised by Galileo three centuries ago and the other in modern times by Michelson with the aid of his interferometer, illustrate the point. Galileo dropped heavy bodies from the top of the leaning tower of Pisa and demonstrated that those of different weights fall to the ground in the same time. As regards experimental skill and delicacy of apparatus, this experiment could have been made many centuries earlier. Moreover, the ideas involved merely concerned weight and speed of travel, ideas familiar to people of ancient times.

But Michelson's experiment could not have been made earlier than it was. It required the general advance of technology as well as Michelson's experimental genius. It concerns the earth's motion through the ether, the all-pervading medium of light waves. Michelson's ingenious apparatus required the finest of optical parts, the products of the contemporary optical glass workers. Accordingly, it may be said that the perfection of glass technology made possible the Michelson interferometer, which in turn resulted in an experiment that formed the basis of Einstein's theory, a theory which has revolutionized not only our understanding of physics, but also our entire philosophy! Indeed, two philosophers, Alfred Whitehead and Victor Lenzen, provided these illustrations which I have borrowed.

And so leaving in your minds the essential rôle of pure science in modern technological progress and the

equal importance of modern technology for the advance of science, I shall close, acknowledging my obligation to these modern philosophers by quoting from one who was a contemporary of Galileo—for it was Sir Francis Bacon who said, "Nature to be commanded must first be obeyed. Knowledge is power."

THE NUTRITIVE SIGNIFICANCE OF THE AMINO ACIDS AND CERTAIN RELATED COMPOUNDS[1,2]

By Professor W. C. ROSE
UNIVERSITY OF ILLINOIS

THE relation of the amino acids to growth has been the subject of numerous investigations during the past thirty years. Until comparatively recently, however, only three of these compounds, namely, tryptophane, lysine and histidine, had been shown definitely to be indispensable components of the food. Evidence which appeared to demonstrate the essential nature of cystine was presented by Osborne and Mendel; while certain other protein components, notably the dibasic amino acids and the prolines, seemed to be dispensable.[3]

Progress in such investigations was hampered by reason of the fact that methods were not available for the quantitative removal of single protein components. It appeared that if further information was to be obtained, one must resort to the use of diets in which the proteins were replaced entirely by mixtures of highly purified amino acids. Such investigations have been under way in this laboratory since 1930.

It soon became apparent that the *known* amino acids, when incorporated in otherwise adequate diets, were incapable of supporting growth. Evidently, proteins supply something which was not present in our original mixtures. This led eventually to the isolation and identification of a new indispensable constituent, namely, α-amino-β-hydroxy-n-butyric acid.[4] This compound is widely distributed in nature, but appears to occur in greatest abundance in the blood proteins. It has been named d-threonine, inasmuch as its spatial configuration is exactly analogous to that of the sugar d-threose.[5] When threonine is added to suitable amino acid mixtures the resulting preparation is an excellent substitute for dietary proteins.

In all our investigations young albino rats from our own colony have served as the experimental animals. The diets have carried the usual components—carbohydrates, fats, inorganic salts and vitamins—and differed from the ordinary so-called "synthetic" rations only in that proteins were replaced by amino acids. Food and water were kept in the cages at all times, so that the animals ate and drank *ad libitum*. By such a procedure, the importance of the individual amino acids has been determined by omitting them from the food one or more at a time.

Data have already been presented elsewhere demonstrating the indispensable nature of phenylalanine,[6] leucine and isoleucine.[7] It has also been shown that hydroxyglutamic acid,[8] citrulline,[9] tyrosine,[6] norleucine,[7] glycine and serine[10] are non-essential. During the past eighteen months all the generally recognized amino acids present in proteins have been classified with respect to their growth importance. It is the purpose of this note to present these findings, together with an outline of the physiological behavior of certain optically isomeric amino acids and related compounds. The evidence upon which the following statements are based will be described in detail elsewhere.

Contrary to the usual belief, cystine is not an indispensable component of the food. On the other hand, methionine is indispensable. In the absence of the latter from the ration, animals rapidly lose weight and eventually die, even though an abundant amount of cystine is supplied. Of particular interest in this connection is the fact that if methionine is administered at a level which permits maintenance or slow increase in weight, the addition of cystine greatly improves the quality of the diet. Thus, cystine stimu-

[1] Aided by a grant from the Rockefeller Foundation.

[2] This paper is a summary of one presented before the joint session of the Federation of American Societies for Experimental Biology at Memphis, Tenn., April 22, 1937. The author is indebted to Drs. Madelyn Womack, S. H. Eppstein, C. E. Meyer and a number of graduate students for the actual conduct of the experiments.

[3] The earlier literature is reviewed by W. C. Rose, *Yale Jour. Biol. and Med.*, 4: 519, 1932.

[4] R. H. McCoy, C. E. Meyer and W. C. Rose, *Jour. Biol. Chem.*, 112: 283, 1935–36.

[5] C. E. Meyer and W. C. Rose, *Jour. Biol. Chem.*, 115: 721, 1936.

[6] M. Womack and W. C. Rose, *Jour. Biol. Chem.*, 107: 449, 1934.

[7] M. Womack and W. C. Rose, *Jour. Biol. Chem.*, 116: 381, 1936.

[8] W. Windus, F. L. Catherwood and W. C. Rose, *Jour. Biol. Chem.*, 94: 173, 1931.

[9] C. T. Caldwell and W. C. Rose, *Jour. Biol. Chem.*, 107: 57, 1934.

[10] R. H. McCoy and W. C. Rose, *Jour. Biol. Chem.*, 117: 581, 1937.

lates growth *only when methionine is supplied in sub-optimal quantities.*

Valine also is an essential component of the food. Despite its structural simplicity, it can not be synthesized by the organism. Its absence from the diet induces a profound failure in growth accompanied by the development of symptoms which are unlike any we have encountered in other types of deficiencies. Animals deprived of valine become sensitive to touch and manifest a severe lack of coordination in movement. Whether the symptoms are associated with specific lesions of the nervous system remains to be determined. As would be expected, the condition is readily cured by the administration of the amino acid.

Several years ago Scull and Rose[11] demonstrated that arginine can be synthesized by the animal organism. It seemed unlikely, therefore, that this amino acid would prove to be an essential. However, following its exclusion from the ration the experimental animals increase in weight at only about three fourths of the normal rate. The addition of arginine to the food remedies the dietary defect. Evidently, the synthesis of this amino acid *in vivo* does not keep pace with the demands of *normal* growth. Thus arginine is unique in that it alone of the essential group may be excluded from the food without occasioning a *loss* in weight.

In contrast to the indispensable amino acids, a number of others have been shown to be dispensable. Alanine, aspartic acid, glutamic acid, proline and hydroxyproline belong to this group. The exclusion of any one of these from the food fails to inhibit growth, or to exert any other detrimental effect under the conditions of our experiments.

The above observations are summarized in Table 1. As a more severe test of the correctness of the above classification, experiments were conducted in which animals received a diet devoid of all the non-essential acids. Under such extraordinary conditions, necessitating the synthesis of twelve tissue components simultaneously, a failure in growth would not have been surprising. As a matter of fact, excellent growth occurred, thereby providing the final proof that only ten of the twenty-two components of proteins need be administered preformed. However, attention should be called to the fact that these findings do not exclude the possibility that functions other than growth, notably reproduction and the detoxication mechanism, may necessitate the administration of other amino acids. The results of such studies will be reported at a later date.

Incidental to the above investigations, tests have been made of the nutritive value of the optical antipodes of the essential amino acids. Data already in the literature show that d-tryptophane[12] and d-histidine[13] can serve in place of their enantiomorphs. On the other hand, l-lysine is said to be incapable of replacing d-lysine,[14] an observation which we have confirmed by the use of diets of purified amino acids. Recently, it has been shown in this laboratory that both forms of phenylalanine and of methionine[15] promote growth. The unnatural isomers may not be quite so efficient as the natural, although the differences in this respect are slight. But only the natural forms of valine, leucine and isoleucine are effective. Furthermore, d- and l-alloisoleucine are completely incapable of replacing d-isoleucine.

Experiments were also undertaken to establish how much of each indispensable amino acid is necessary to induce optimum growth. This was accomplished by varying the proportions of one while maintaining all others at constant levels. The results are summarized in Table 2 and are to be regarded as *strictly tentative.* The values represent the *percentages* of the natural amino acids which must be present in the

TABLE 1

FINAL CLASSIFICATION OF THE AMINO ACIDS WITH RESPECT TO THEIR GROWTH EFFECTS

Essential	Non-essential
Lysine	Glycine
Tryptophane	Alanine
Histidine	Serine
Penylalanine	Norleucine
Leucine	Aspartic acid
Isoleucine	Glutamic acid
Threonine	Hydroxyglutamic acid
Methionine	Proline
Valine	Hydroxyproline
*Arginine	Citrulline
	Tyrosine
	Cystine

* Arginine can be synthesized by the animal organism, but not at a sufficiently rapid rate to meet the demands of *normal* growth.

[11] C. W. Scull and W. C. Rose, *Jour. Biol. Chem.*, 89: 109, 1930.

TABLE 2

MINIMUM AMOUNT OF EACH ESSENTIAL AMINO ACID NECESSARY TO SUPPORT NORMAL GROWTH WHEN THE NON-ESSENTIALS ARE INCLUDED IN THE FOOD

Amino acid	Per cent.
Lysine	1.0
Tryptophane	0.2
Histidine	0.4
Phenylalanine	0.7
Leucine	0.9
Isoleucine	0.5
Threonine	0.6
Methionine	0.6
Valine	0.7
Arginine	0.2
	5.8

[12] V. du Vigneaud, R. R. Sealock and C. Van Etten, *Jour. Biol. Chem.*, 98: 565, 1932; C. P. Berg, *Jour. Biol. Chem.*, 104: 373, 1934.

[13] G. J. Cox and C. P. Berg, *Jour. Biol. Chem.*, 107: 497, 1934.

[14] C. P. Berg, *Jour. Nutrition*, 12: 671, 1936.

[15] See also R. W. Jackson and R. J. Block, *Proc. Soc. Exp. Biol. and Med.*, 30: 587, 1933.

rations. From the food intakes, which are not included in this note, one can calculate the milligrams of each amino acid which were consumed by the animals daily. This may prove to be a more accurate method of expressing the data. It should be emphasized that factors such as the proportion of fat and carbohydrate in the ration, and the age, weight and sex of the subjects may play important rôles in determining the minimum level of a given component. Furthermore, we have not yet investigated the possibility of inducing growth when the animals receive only ten amino acids *each at the minimum level*. If normal increases in weight occur on restricted diets of this nature, the amino acid mixture will prove to be the most efficient source of nitrogen ever devised for the purpose. On theoretical ground it appears more likely that growth will not occur. As indicated above, the values in Table 2 were obtained when liberal quantities of the non-essential amino acids were furnished. In the absence of the non-essential group, the nitrogen intake probably would be inadequate to meet the synthetic demands. In this event, a method will become available for the study of the origin of each dispensable amino acid and of the chemical transformations involved in its formation.

Finally, additional information has been obtained on the replacement of amino acids for growth purposes by the corresponding α-hydroxy and α-keto acids. The results of unpublished experiments demonstrate that phenylalanine, leucine and isoleucine can be replaced by both the hydroxy and keto compounds. Valine is replaceable by α-hydroxyisovaleric acid. Tests with the corresponding α-ketoisovaleric acid have not yet been completed.

OBITUARY

NATHANIEL LYON GARDNER

NATHANIEL LYON GARDNER was born in Keokuk, Iowa, on February 26, 1864. He passed away at his home in Berkeley on August 15, 1937. Graduating from the high school at Iowa Falls, he, after passing the necessary examinations, began teaching school in Iowa, but soon removed to Tacoma, Washington, to enter business with a relative. After the panic of 1893 he returned to teaching, having graduated from the normal school at Ellensburg, Washington. He received the degree of B.S. from the University of Washington in 1900, that of M.S. from the University of California in 1903 and that of Ph.D. in 1906.

As a teacher in the schools, he was soon called to Island County, in the State of Washington. Here he continued studies in natural history which had intrigued him even in his earlier years in Iowa, collecting specimens, of most excellent character, of various groups of plants and sending them to eminent authorities for determination and advice. In 1897, while teaching school at Coupeville, he addressed a letter to the writer at the University of California, asking for instruction in preparing, and assistance in determining, specimens of marine algae, of which he estimated there were about sixty-five species in his neighborhood. There began at that time a cooperation between Gardner and Setchell which increased in scope and lasted until the death of the former. Due to their combined efforts the knowledge of the marine algae of the Pacific coasts of North America was tremendously advanced.

Professor Gardner was an extraordinary collector, with keen insight, careful selection and skilful manipulation, so that his specimens and his knowledge increased side by side. When it came to publicaton, he was most meticulous. Some thirty or more papers were published under his name, while many more than that were published as joint papers with the writer.

He was an authority on blue-green algae of the world, as well as those of the Pacific coasts of North America. His knowledge of the green algae, while more limited to the marine species, was nevertheless extensive and he made very valuable contributions towards a better knowledge of the morphology and development of many species of this group. When it comes to the brown algae, his researches in various groups, from the minute forms to the more gigantic, were characterized not only by the distinguishing of many new species, but by substantial additions to our knowledge of their morphology and development. He was engaged particularly in the study of various polymorphous genera of the red algae of our Pacific coasts at the time of his death.

Professor Gardner, through his wonderful patience in collecting, culturing and studying his specimens, was rapidly bringing order out of the chaos of our knowledge as it previously existed. His work along these lines was cut short, much to the detriment of all those who are interested.

He served the University of California as assistant in botany from 1900 to 1906, as acting assistant professor of botany during the academic year 1909–1910, as assistant professor of botany from 1913 to 1923, as associate professor of botany from 1923 to 1934, and was retired in 1934 as associate professor of botany, emeritus. In 1920 he was also appointed curator of the herbarium of the University of California, which position he held until his retirement in 1934, when he was made curator, emeritus. He was head of the department of biology in the Los Angeles Poly-

technic High School from 1906 to 1909 and 1910 to 1913.

He married, in 1915, Edith Jordan (daughter of David Starr Jordan, then chancellor of Leland Stanford Junior University), who survives him. He was a member of both the scholastic honor societies, Phi Beta Kappa and Sigma Xi.

WILLIAM ALBERT SETCHELL

RECENT DEATHS AND MEMORIALS

DR. FRANK NELSON BLANCHARD, associate professor of zoology at the University of Michigan, died on September 21 at the age of forty-nine years.

DR. PAUL EMERSON, senior soil scientist of the Soil Conservation Service of the U. S. Department of Agriculture, previously associate professor of soils at the Iowa State College, died on September 20 in a canyon eight miles from Rapid City, South Dakota, while attempting to stem the poison of a rattlesnake bite. He was fifty years old.

DR. WILFRED N. STULL, vice-president of the Mallinckrodt Chemical Works in charge of operations and research, died on September 17 at the age of sixty years.

DR. CHARLES H. EHRENFELD died on September 25 at the age of seventy-three years. Dr. Ehrenfeld had been associated with the York Collegiate Institute, Pennsylvania, for forty-one years, having joined the faculty in 1887 as professor of chemistry and physics. He held the presidency from 1916 until 1928. From 1903 to 1916 he was chief chemist of the York Ice Machinery Corporation, makers of refrigeration machinery, later becoming a consulting chemist.

DR. JOHN WOODFORD FARLOW, librarian emeritus of the Boston Medical Library, formerly instructor in laryngology at the Harvard Medical School, died on September 23. He was eighty-four years old.

THE Division of Botany of the College of Agriculture of the University of California at Davis on September 15 held a special seminar commemorating the one hundredth anniversary of the discovery of the sieve tube by Theodor Hartig. Dr. Katherine Esau read a paper reviewing the development of present-day knowledge of sieve-tube structure and ontogeny. Dr. Alden S. Crafts discussed the part played by the sieve tube in translocation. A number of papers, including several of Hartig's reports, were on display. There was also a demonstration of microscopic slides illustrating sieve-tube anatomy and ontogeny.

SCIENTIFIC EVENTS

NATIONAL FOUNDATION FOR INFANTILE PARALYSIS

PRESIDENT ROOSEVELT has announced that he is forming a national foundation to unify the fight against infantile paralysis. It is planned to finance the new foundation through a nation-wide solicitation of private contributions. The goal will be from $7,000,000 to $10,000,000 in the next five years. Also to be used will be receipts from the President's birthday balls, held throughout the country. The Warm Springs Foundation's share of these receipts this year amounted to $340,000. In addition the balls raised about $660,000 for the work in the localities in which it was raised.

The text of President Roosevelt's statement is as follows:

I have been very much concerned over the epidemics of infantile paralysis which have been prevalent in many cities in different parts of the country. I have had reports from many areas in which this disease is again spreading its destruction.

And once again there is brought forcibly to my mind the constantly increasing accumulation of ruined lives—which must continue unless this disease can be brought under control and its after-effects properly treated.

My own personal experience in the work that we have been doing at the Georgia Warm Springs Foundation for over ten years leads me to the very definite conclusion that the best results in attempting to eradicate this disease can not be secured by approaching the problem through any single one of its aspects, whether that be preventive studies in the laboratory, emergency work during epidemics, or after-treatment.

For over ten years at the foundation at Warm Springs, Ga., we have devoted our effort almost entirely to the study of improved treatment of the after-effects of the illness. During these years other agencies, which we have from time to time assisted, have devoted their energies to other phases of the fight.

I firmly believe that the time has now arrived when the whole attack on this plague should be led and directed, though not controlled, by one national body. And it is for this purpose that a new national foundation for infantile paralysis is being created.

As I have said, the general purpose of the new foundation will be to lead, direct and unify the fight on every phase of this sickness. It will make every effort to insure that every responsible research agency in this country is adequately financed to carry on investigations into the cause of infantile paralysis and the methods by which it may be prevented.

It will endeavor to eliminate much of the needless after-effect of this disease—wreckage caused by the failure to make early and accurate diagnosis of its presence.

We all know that improper care during the acute stage of the disease, and the use of antiquated treatment, or

downright neglect of any treatment, are the cause of thousands of crippled, twisted, powerless bodies now. Much can be done along these lines right now.

The new foundation will carry on a broad-gauged educational campaign, prepared under expert medical supervision, and this will be placed within the reach of the doctors and the hospitals of the country.

The practicing physician is in reality the front line fighter of the sickness, and there is much existing valuable knowledge that should be disseminated to him.

And then there is also the tremendous problem as to what is to be done with those hundreds of thousands already ruined by the after-effects of this affliction. To investigate, to study, to develop every medical possibility of enabling those so afflicted to become economically independent in their local communities will be one of the chief aims of the new foundation.

Those who to-day are fortunate in being in full possession of their muscular power naturally do not understand what it means to a human being paralyzed by this disease to have that powerlessness lifted even to a small degree.

It means the difference between a human being dependent on others, and an individual who can be wholly independent. The public has little conception of the patience and time and expense necessary to accomplish such results. But the results are of the utmost importance to the individual.

The work of the new organization must start immediately. It can not be delayed. Its activities will include, among many others, those of the Georgia Warm Springs Foundation, of which I have been president since its inception. I shall continue as president of that foundation.

But in fairness to my official responsibilities, I can not at this time take a very active part in the much broader work that will be carried out by the new foundation, and I therefore do not feel that I should now hold any official position in it.

However, because I am wholeheartedly in this cause, I have enlisted the sincere interest of several representatives and outstanding individuals who are willing to initiate and carry on the work of the new foundation. Its personnel will be announced as soon as it is completed.

NEW APPOINTMENTS AT COLUMBIA UNIVERSITY

NEW appointments in the sciences at Columbia University are as follows:

Dr. Samuel James Shand, of the University of Stellenbosch, South Africa, professor of geology.

Dr. William Duncan Strong, senior ethnologist of the Bureau of American Ethnology of the Smithsonian Institution, Washington, D. C., associate professor of anthropology.

Francis Hodgkinson, retired consulting engineer of the Westinghouse Electric and Manufacturing Company, honorary professor of mechanical engineering.

Dr. Ralph Linton, of the University of Wisconsin, visiting professor of anthropology.

Dr. George Herzog, of Yale University, visiting assistant professor of anthropology.

Dr. Henry Abraham Boorse, of the College of the City of New York, assistant professor of physics in Barnard College.

Dr. Maurice Biot, of the University of Louvain, assistant professor of mechanics.

Dr. Magnus I. Gregersen, of the University of Maryland, professor and head of the department of physiology in the School of Medicine.

Dr. Walter S. Root, of the University of Maryland, associate professor of physiology.

Dr. George Gray Ward, chief surgeon at the Woman's Hospital, clinical professor of obstetrics and gynecology.

Dr. William Holmes Stewart, director of the department of radiology in the Lenox Hill Hospital, clinical professor of radiology.

Dr. Ralph A. Hurd, surgeon at the Woman's Hospital, assistant clinical professor of obstetrics and gynecology.

Dr. Earl E. Van Derwerker, orthopedic surgeon at the Hospital for the Ruptured and Crippled, assistant professor of clinical orthopedic surgery.

Dr. Albert H. Aldridge, assistant chief surgeon at the Woman's Hospital, assistant clinical professor of obstetrics and gynecology.

THE GOLDEN GATE INTERNATIONAL EXPOSITION

A COMMITTEE of leading western medical men has been formed to work out the details of the health exhibit for the 1939 Golden Gate International Exposition. The major emphasis will be placed on the prevention of disease rather than on its treatment. In keeping with the "Pageant of the Pacific" theme of the exposition, the contributions of Pacific nations toward the health of humanity will be dramatized. Proper nutrition, practical knowledge of vitamins, sanitation, vaccination and other matters of public health will be explained for the layman.

The plans have the cooperation of several American universities, notably the University of California, Stanford University, the University of Southern California, California Institute of Technology, Harvard University, University of Oregon and the University of Washington.

The committee includes:

Dr. Chauncey D. Leake, *chairman*, head of the department of pharmacology of the Medical School of the University of California, an international expert on anesthetics and amebic dysentery; Dr. J. C. Geiger and Dr. Paul Barrett, of the San Francisco Department of Health; Dr. Walter Brown, of Stanford University, past-president of the American Public Health Association; Dr. Francis Carmelia, representing Dr. Thomas Parran, Jr., Surgeon-General of the United States; Dr. L. R. Chandler, dean of the Medical School of Stanford University; Dr. Walter Dickie, head of the California State Department of Public Health; Dr. William Dock, head

of the department of pathology, Stanford University, known for his work on the abnormalities of the circulatory system; Waldemar Gnerich, secretary, Northern California Retail Druggists' Association, representing druggists' associations of the eleven western states; Dr. Charles Gilman Hyde, University of California engineer; Dr. T. Henshaw Kelly, president of the San Francisco County Medical Society, an experienced public relations worker for the California Medical Association; Dr. John Leggett, representing the California State Dental Association; Dr. Wilfrid Robinson, representing the American Dental Association; Dr. K. F. Meyer, director of the Hooper Foundation and head of the department of bacteriology of the Medical School of the University of California; Dr. Guy Millberry, dean of the School of Dentistry, official representative of the American Public Health Association; Dr. Langley Porter, dean of the Medical School of the University of California; Dr. William Shepard, Metropolitan Life Insurance Company, representing the American Public Health Association; Dr. Nina Simmonds, of the Medical School of the University of California, a nutrition authority; Dr. F. C. Warnshuis, secretary of the California Medical Association, and Dr. C. L. A. Schmidt, head of the department of biochemistry of the University of California.

The committee is working out the details of its exhibit with Milton Silverman, head of the Health and Science Division.

MEETING OF PHYSICISTS OF UPPER NEW YORK STATE

FOR some time there has been a growing sentiment toward the formation of a section of the American Physical Society for Upper New York State. After due canvassing of the members of the Physical Society of that territory, plans have been formulated for a meeting to be held at Cornell University under the auspices of the American Physical Society on Saturday, November 6.

At that meeting final action will be taken on the question as to whether a section of the American Physical Society shall be formed. In the event of such formation it is contemplated that membership will be available to teachers of physics in colleges and in high schools, to physicists in the industries and to other physicists without regard to membership in the American Physical Society.

A program, to which all interested physicists are invited, has been prepared, starting at 10 A. M. and comprising the following:

Address of Welcome, Dr. Edmund E. Day, president of Cornell University.

"A Quarter Century of Progress in Physics," L. A. DuBridge, University of Rochester.

"Physical Problems of Industrial Radiography," Herman E. Seemann, Eastman Kodak Company.

"Cooling an Automobile Engine," L. P. Saunders, Harrison Radiator Division, General Motors Company.

"The Theory of Electrical Measuring Instruments," F. C. Bobie, General Electric Company.

"Abrasives and Their Uses," E. T. Hager, Carborundum Company, Niagara Falls, New York.

"Physics in the Small College," Paul F. Gaehr, Wells College.

Members of the committee in charge of the movement are: G. H. Cameron, Hamilton College; R. C. Gibbs, Cornell University; H. P. Gage, Corning Glass Company; L. G. Hector, University of Buffalo, and P. I. Wold, *chairman,* Union College.

THE WORLD CONGRESS OF UNIVERSAL DOCUMENTATION

REPRESENTATIVES of forty-five countries, who attended the World Congress of Universal Documentation held recently in Paris, discussed the methods and necessities of forming a unified system of the mass of recorded information contained in books, periodicals and other publications.

The congress passed resolutions urging the establishment of microfilm copying services in libraries throughout the world and specifically suggested that manuscript and graphic material gathered by the weather services should be made available by means of microfilm. Resolutions also were passed concerning the uniform preparation of articles for technical and scientific periodicals; the standardization of methods of classifying books and other documents; the preparation of union catalogues; the indexing of daily newspapers; card bibliographies; the gathering of literature on documentation techniques; cooperation between specialized organizations and libraries, and the establishment of agencies for the distribution of official documents.

Dr. Jean Gerard, of the Maison de la Chimie, was the president and organizer of the congress. Others who attended were Paul Otlet, founder of the organization now known as the International Institute of Documentation; Dr. H. Krüss, director general of the State Library at Berlin, who headed the German delegation of more than twenty persons; H. G. Wells; Hilary Jenkinson, head of the archives of the British Foreign Office; Julien Cain, general administrator of the French National Library; Dr. Pierre Bourgeois, of the Maison de la Chimie; Dr. Alingh Prins, head of the Dutch Patent Office and president of the International Institute of Documentation, and Marcel Godet, director of the Swiss National Library and president of the International Committee of Libraries.

The American delegation included Dr. Worthington C. Ford, honorary European representative of the

Library of Congress; Herman H. Fussler, head of the laboratory of microphotography of the University of Chicago; Professor Douglas Waples, of the Graduate Library School of the University of Chicago; Miss Sabra M. Vought, librarian of the U. S. Office of Education, and Watson Davis, director of Science Service and chairman of the delegation.

The International Institute of Documentation, a union of documentation centers, was asked by the congress to become the International Federation of Organizations of Documentation and a permanent international committee to have charge of the organization of future congresses was considered. The next congress is to be held in Frankfurt, Germany, in 1940.

SCIENTIFIC NOTES AND NEWS

LORD RAYLEIGH has been elected president of the British Association for the Advancement of Science to succeed Sir Edward Poulton, whose presidential address before the Nottingham meeting was printed in the issue of SCIENCE for September 3. Lord Rayleigh's father, also distinguished for his work in physics, was president of the association when it met in Montreal in 1884. The next annual meeting of the association will be held at Cambridge in August, 1938.

DR. LEO HENDRIK BAEKELAND has been elected an honorary member of the French Society of Chemical Industry in recognition of the eminent services he has rendered to science and industry. The society observed its twentieth anniversary in Paris in conjunction with the Congress of Chemical Industry. Certificates of honorary membership were presented in the presence of the President of the French Republic.

THE medal committee of the American Section of the Society of Chemical Industry has awarded to Dr. E. J. Crane, the Ohio State University, editor of *Chemical Abstracts,* the Chemical Industry Medal for 1937. This medal is given annually for a valuable application of chemical research to industry. The medal will be presented on November 5 at a meeting to be held at The Chemists' Club, New York City.

DR. JOHN D. LONG, of the U. S. Public Health Service, has received the Order of Merit of the Government of Ecuador for leading the campaign of the Pan-American Sanitary Bureau against bubonic plague.

PROFESSOR S. LEFSCHETZ, of Princeton University, has been elected a corresponding member of the Reale Accademia di Scienze, Lettere ed Arti di Padova.

PROFESSOR GEORGE GRANT MACCURDY, of Yale University, director of the American School of Prehistoric Research, has been elected to honorary corresponding membership in the Prehistoric Society of Great Britain and in the British Speleological Association.

AT the Chicago meeting of the Roentgen Ray Society, held in connection with the fifth International Congress of Radiology, Dr. B. R. Kirklin, of the Mayo Clinic, became president for the year, and Dr. John W. Pierson, of Baltimore, president-elect. Dr. E. Forest Merrill, of New York City, was elected a second vice-president. It was voted to hold the next annual meeting in Atlantic City during the week of September 19, 1938.

DR. HARVEY AGNEW, of Toronto, was elected on September 16 to the presidency of the American Hospital Association at its thirty-ninth annual convention in Atlantic City. Dr. Agnew is secretary of the hospital service department of the Canadian Medical Association.

DR. J. HOLMES MARTIN, in charge of poultry husbandry at the Experiment Station of the University of Kentucky, has been made head of the department of genetics. W. G. Haig has been appointed curator of the Museum of Anthropology and Archeology.

DR. FRANK HAROLD SPEDDING, of Cornell University, has been appointed associate professor of physical chemistry at the Iowa State College. Dr. Spedding won the A. C. Langmuir award of the American Chemical Society in 1933 and has been the recipient of both National Research Council and Guggenheim fellowships.

NEIL RIGLER, of the Squibb laboratories, has been placed in charge of the research laboratory of the North Carolina Agricultural Experiment Station. He will work with Dr. Emerson R. Collins, who was formerly connected with the Cotton Root Rot Division of the U. S. Department of Agriculture in Austin, Texas.

DR. EDWARD MCCRADY, JR., associate of the Wistar Institute of Anatomy, Philadelphia, has been appointed chairman of the department of zoology at the University of the South, Sewanee, Tenn.

DR. ROGER D. REID, a member of the department of animal pathology at the University of Idaho, has joined the faculty of the Johns Hopkins University.

APPOINTMENTS at the School of Medicine of the University of Oklahoma include: Dr. Berry Campbell, national research fellow in comparative anatomy, to be assistant professor of anatomy; Albert J. Sheldon, the Johns Hopkins University School of Hygiene and Public Health, assistant professor of bacteriology *ad interim;* Francis C. Lawler, Emory Lab-

oratory of Cancer Research, St. Luke's and Children's Hospital, Philadelphia, assistant professor of bacteriology; Dr. Irvin S. Danielson, teaching fellow in biological chemistry, Harvard University Medical School, assistant professor of biochemistry; Dr. Arnold J. Lehman, instructor in pharmacology, Stanford University School of Medicine, assistant professor of pharmacology, and Dr. Onie Owen Williams, instructor in pathology, University of California Medical School, assistant professor of pathology.

ACCORDING to a cable dispatch to the newspapers Professor Gustave Roussy, dean of the School of Medicine of the University of Paris, known for his work on cancer and nervous diseases, has been elected rector to succeed M. Sébastien Charléty.

PROFESSOR A. W. FALCONER, professor of medicine at the University of Capetown, will succeed Sir Carruthers Beattie as principal and vice-chancellor of the university. Sir Carruthers retires at the end of the year.

PROFESSOR LUCIEN CORNIL, head of the department of pathology in the medical school of the University of Marseille, has been elected dean of the faculty to succeed Professor Imbert.

DR. WINFRED OVERHOLSER, commissioner of the Massachusetts State Department of Mental Diseases, has been appointed by President Roosevelt superintendent of St. Elizabeth's Hospital at Washington. He succeeds the late Dr. William Alanson White, who was superintendent of the hospital from 1903 until his death in March, 1937. Since then Dr. Roscoe W. Hall, senior physician on the staff of the institution, has been acting as superintendent.

DR. JOHN H. TRUESDAIL, recently a fellow of the Rockefeller Foundation, working with Dr. Roger J. Williams at Oregon State College, has become associated with Truesdail Laboratories, Inc., in Los Angeles. Dr. Truesdail received his degree in organic chemistry at the University of Michigan in 1934. Truesdail Laboratories, Inc., was founded and is directed by his brother, Dr. Roger W. Truesdail.

Nature reports that J. D. Griffith Davies, an administrative assistant in the Higher Education Department at Leeds, has been appointed assistant secretary of the Royal Society as from September 1, in succession to R.Winckworth, who at his own request has reverted to his previous position in charge of the publications of the society.

PROFESSOR WALTER KUBIENA, of the Agricultural Institute, Vienna, will extend his stay at the Iowa State College as visiting professor of soils through the autumn quarter of 1937.

PROFESSOR ERNST ESCH, head of the Institute of Motor Transport Science at the University of Cologne, has arrived in New York City with twenty-one university students to study transportation and traffic problems. He will speak on October 14 at the meeting of the metropolitan section of the Society of Automotive Engineers, on motorization in Germany and the competition between motor and rail transport.

DR. ROBERT K. ENDERS, of Swarthmore College, has returned to Philadelphia with several thousand natural history specimens, collected on Volcan de Chiriqui in Panama for the Academy of Natural Sciences. The expedition, sponsored by the academy, the American Philosophical Society and Swarthmore College, centered its work on the 11,500 foot extinct volcano, which is the highest peak of Panama. Isolated from the surrounding mountain ranges, this peak is said to be of special interest in the study and collection of animal and plant life, as the forms living on it have not been in general contact with the surrounding country. David Bishop, of the University of Pennsylvania; Dr. C. Brooke Worth, Samuel Cresson and Oliver Pearson, of Swarthmore College, accompanied Dr. Enders.

UNDER the U. S. Geological Survey field examinations of the Green River and associated formations in the fossil syncline, southwestern Wyoming, including study of the quality and distribution of oil shale beds, have been completed by W. H. Bradley. The field work also included an extended study of the beds which have furnished the museums of the world with the finest known specimens of fossil fish. Field studies and mapping of the coal resources and oil and gas prospects of the area surrounding the Little Rocky Mountains, Mont., have been completed by M. M. Knechtel. A geological and geophysical survey of the Austin mining district, Nevada, using magnetometer and resistivity methods, is being made by C. P. Ross and E. L. Stephenson. S. R. Capps, who has been engaged for the past three months in field work on the placer deposits of central Idaho, in the vicinity of Grangeville, has completed his season's work and has returned to Washington.

PROFESSOR MAURICE SOURDILLE, of the School of Medicine at Nantes, will deliver an illustrated lecture on "New Technics in the Surgical Treatment of Deafness from Otosclerosis" before the section of otolaryngology of the New York Academy of Medicine at a special meeting on October 6. The lecture will be given in English.

PROFESSOR THE. SVEDBERG, of the University of Upsala, will be the guest of honor at the dedication on October 15 and 16 of the new building for chemistry at the University of Delaware. The building was

made possible by a gift of $300,000 from an unknown donor.

THE hundredth anniversary of the Division of Science and of the State Museum at Albany will be observed on October 15 at the annual convocation of the University of the State of New York. Scientific men and interpreters of the relation of science to the state and to society will take part in the two sessions to be held in the State Education Building. The speakers at the first session will be Dr. John C. Merriam, president of the Carnegie Institution of Washington; Dr. C. Stuart Gager, director of the Brooklyn Botanic Garden, and Lewis Mumford, writer, of New York City. Dr. Arthur E. Morgan, chairman of the Tennessee Valley Authority, and Waldemar B. Kaempffert, science editor of *The New York Times,* will speak at the evening session. Dr. Morgan's subject will be "The Relation of Electricity to Social Policy." Mr. Kaempffert will discuss "Science and Democracy."

SECTION I (Psychology) of the American Association for the Advancement of Science will meet in Indianapolis from Monday, December 27, to Wednesday, December 29. In addition to the usual program of contributed papers, there will be on December 28 a symposium on "The Endocrines as Related to Behavior," under the chairmanship of Dr. Calvin P. Stone, of Stanford University. All fellows and members of the section who wish to read papers should submit abstracts in duplicate (not more than 300 words in length) of the papers which they wish to present, giving the time required for presentation up to a limit of 15 minutes. Abstracts should reach the Section Secretary, Dr. Leonard Carmichael, Department of Psychology, University of Rochester, Rochester, New York, not later than November 6.

THE seventeenth annual meeting of the Highway Research Board of the National Research Council will be held in Washington, D. C., from Tuesday, November 30, to Friday, December 3. Papers and committee reports relating to highway finance, economics, design, materials and construction, maintenance, soils, roadside development and safety will be presented. This year the formal meeting of the board will be interspersed with open departmental meetings for informal discussion.

ACCORDING to *The Museum News,* the South African Museums Association has held its first annual general meeting at Kingwilliamstown, Cape Province, with seventeen representatives of institutional members present. The retiring president, C. J. Swiestra, reported that twenty-four of the museums of South Africa and Rhodesia had joined the association during the year since the inaugural meeting, leaving only a very few not yet affiliated with the association. For the year 1937–38, E. L. Gill, South African Museum, Capetown, was elected president; E. C. Chubb, Durban Museum and Art Gallery, was reelected secretary-treasurer, and G. Arnold, Rhodesian Museum, Bulawayo, John Hewitt, Albany Museum, Grahamstown, G. C. Shortridge, Kaffrarian Museum, Williamstown, and C. J. Swiestra, Transvaal Museum, Pretoria, councilors. The association voted to hold the next meeting immediately following Easter, 1938, at Durban in the Province of Natal.

BY the will of Miss Amelia Marburg, who died on September 9, the Johns Hopkins University and the Johns Hopkins Hospital each receive the sum of $50,000.

THE *Journal* of the American Medical Association reports that a trust fund of a million dollars has been given by Miss Emily Renziehausen to the Children's Hospital for "perpetual research in the causes, treatment and cure of diabetes in the youth of the Pittsburgh area." The first income of the fund will be used to build an addition to the hospital to be known as the Renziehausen Memorial Ward and Clinic. In addition Miss Renziehausen has given an eleven-acre farm as a site for a home for convalescent children. The fund agreement provides that income not needed for work on diabetes may be devoted to other research work and to hospital service. Drs. Frederick E. Kredel, Richard A. Kredel and Thomas T. Sheppard were named a committee to supervise the fund, of which the Union Trust Company is trustee.

Nature reports that the library of the Radcliffe Observatory, Oxford, is about to be transferred to its new quarters in South Africa, and publications intended for it should now be addressed to "The Radcliffe Observatory, Pretoria, South Africa," instead of to Oxford.

DISCUSSION

ANAPHYLAXIS

RICHET and associates[1] introduced the term "anaphylaxis" to describe the condition of diminished tolerance toward a mildly poisonous material unexpectedly encountered by them in experimental animals at a certain time after previous injection of the same material. Richet had expected to produce by his inoculations an *increased* tolerance or immunity (and indeed he did so eventually), but when his animals were reinjected at a certain time interval they were not more,

[1] P. Portier and Ch. Richet, *Compt. rend. Soc. de Biol.,* 54: 170, 1902.

but *less* resistant, exhibiting such a marked sensitivity that they were killed or made severely ill by doses even smaller than those tolerated without harm by normal, untreated animals. In these circumstances the earlier injections seemed to have had, Richet said, an *anaphylactic* effect, that is, an effect contrary to or the inverse of the *prophylactic* (protective) effect he had anticipated. In several of Richet's publications he defined his new word "anaphylaxis" as "the contrary of protection" (*contraire de la phylaxie*).[1,2,3] Unfortunately, Richet did not explain the exact shade of meaning he attributed to the Greek prefix *ana,* but it seems evident that he was using one of its common meanings, *back* or *backward,* in a somewhat uncommon way, in the sense of *in back, in reverse* or *inverse.* Thus, the term was compounded of Greek *ana,* the inverse or contrary of, plus Greek *phylaxis,* protection. Ramon has more recently used the prefix *ana* with exactly this meaning in another important immunological term, "anatoxin."[4]

Richet's literal definition of anaphylaxis appears in the French work "Larousse du XXe Siècle," 1928, but elsewhere it seems to be largely forgotten. In one standard English dictionary[5] we are told that one of the meanings of *ana* is greatly or excessively, "as in anaphylaxis." This would make the term signify literally "excessive protection"—an obvious absurdity. If we turn to three leading American medical dictionaries we find that each has its own interpretation of the word, and none agrees with Richet's. In one (Gould's Medical Dictionary, 4th edition, 1935), the term is said to be made up of Greek *an,* a privative, plus *phylaxis,* thus having the sense "without protection." This is an attractive interpretation, for it is not inconsistent with the situation the word is used to designate, and this definition has been given by others.[6] However, the prefix to be defined is clearly *ana,* not *an.* Another dictionary (Stedman's Medical Dictionary, 13th edition, 1936) gives the following unique construction: "Greek *an,* before a vowel *an,* again, + *a,* privative, + *phylaxis,* protection." Doubtless this may be defended, but it is far-fetched, to say the least, and there is nothing to indicate that the inventor of the word had any such notions.

Finally, in a third dictionary (American Illustrated Medical Dictionary, 17th edition, 1937) we discover still another form of literal definition, and the one now most commonly given in authoritative American textbooks[7] and reviews.[8] According to this definition, the Greek prefix *ana* means "against," and thus anaphylaxis comes to have quite different implications. The original idea of the mere lack of (expected) defense—the contrary of protection—is changed to a concept of active antagonism—"against protection." The difference is important, especially when, as in a recent monograph,[9] this definition is taken as the starting point for theoretical discussion.

Tracing the matter back we find that the interpretation "against protection" apparently originated in no less significant a place than in the classical papers of the pioneer American workers in this field.[10] With all due respect to them, it seems clear that they were in error. The Greek prefix *ana* does indeed have several meanings,[11] but "against" is not one of them. It is true that if we look up the prefix *an,* the first definition given is "against," as in *an*swer, but this is Anglo-Saxon, not Greek.[11]

The writer would be among the first to insist that the *phenomenon* of anaphylaxis is best defined in terms of experimental facts, but the word itself is still with us, and its literal definition should be agreed upon. We see no reason to depart from the original meaning given the term by Richet himself, namely, the contrary of, or the inverse of, protection.

Kenneth L. Burdon
Louisiana State University
Medical Center

PROTOZOAN ECOLOGY[1]

A year's study of protozoan distribution and the sequence of species at several stations in a small artificial lake in Central Oklahoma was made in relation to several environmental factors which have been shown to be of significance to aquatic life. These are temperature, dissolved oxygen, carbon dioxide, and bound and half-bound carbonates, acidity of the water as measured by the *p*H scale, and the major fluctuations of the water level. Approximately two hundred species were collected at least once and forty-five species were taken eight or more times.

Volvox perglobator, several species of *Difflugia* (notably *D. lobostoma*), several species of *Euglena,* two species of *Tintannus, Halteria grandinella* and a few others seemed to be favored by temperatures which were not low. Some species seemed to be

[2] Ch. Richet, *Ann. de l'Inst. Pasteur,* 21: 497, 1907.
[3] Ch. Richet, "L'anaphylaxie," Paris, 1912.
[4] G. Ramon, *Ann. de l'Inst. Pasteur,* 38: 1, 1924.
[5] Webster's New International Dictionary, 2nd edition, 1935.
[6] *E.g.,* W. Guttman, "Medizinische Terminologie," tenth and eleventh edition, Urban and Schwerzenberg, Berlin, 1919.
[7] *E.g.,* Chapter 6 in Gay, *Agents of Disease and Host Resistance,* Thomas, 1935.
[8] *E.g.,* Chapter 73 in "Newer Knowledge of Bacteriology and Immunology," ed. by Jordan and Falk, University of Chicago Press, 1928.
[9] R. L. Kahn, "Tissue Immunity," Thomas, 1936, pp. 9–11.
[10] M. J. Rosenau and J. F. Anderson, *Jour. Infect. Dis.,* 5: 85, 1908.
[11] Funk and Wagnall's New Standard Dictionary, 1935.
[1] Contributions from the Zoological Laboratories of the University of Oklahoma, No. 182. Preliminary note.

favored by conditions associated with intermediate temperatures. No species was found which preferred cold water, but several forms became active in water which had been ice not more than one hour previously. Most species observed showed a wide range of tolerance to changes in temperature as well as in all the other environmental factors which were studied.

Two fundamentally different sequences of protozoan forms were observed at the ends of piers extending into the lake. Here, the planktonic fauna was markedly different from the fauna on the piles of the piers, although no measurable differences in environmental factors could be found.

It is concluded that: (1) most free-living Protozoa show wide ranges of tolerance to individual environmental factors, a fact also shown by the data of Noland[2] and of Wang;[3] (2) most free-living Protozoa are affected by very slight changes in the physical and biotic conditions of the environment, in spite of the wide ranges of tolerances shown; (3) the sequence of protozoan species at any one place passes very quickly under natural conditions; (4) an abundance of food is very important for the distribution of most species of ciliates, as Noland[2] also found; it is also the major factor in the distribution of the saprozoic flagellates, but is not so necessary to other flagellated types, and it has not been shown to be important in the distribution of the amoeboid forms; (5) flagellates tend to react more directly to individual factors in the environment than do ciliates; amoeboid forms seem to be intermediate in this regard; (6) seasonal maxima in number of species occur approximately one month earlier in the spring and later in the fall in Oklahoma than is common farther north (see Wang[3]). This apparently shows that such maxima are controlled by climatic factors associated with the seasons.

A full report of this study will be published elsewhere.

ARTHUR N. BRAGG
UNIVERSITY OF OKLAHOMA

LEMNACEAE IN FLOWER

ON June 5, 1937, in a small pond north of St. Paul, Minnesota, *Lemna minor* L. was found in flower. About one thallus in ten had flowers. This colony continued to bloom for six weeks, the seed of the first flowers maturing about the time the last flowers appeared. Because of this find and the abundant rains in this area other *Lemnaceae* were watched and were found in flower as follows:

Spirodela polyrhiza (L.) Schleid. in three ponds near Lake Minnetonka, the earliest flowers appearing on July 2, 1937.

Lemna trisulca L. in a pond at Glenwood Park, Minneapolis, Minnesota, on July 10, 1937.

Lemna sp. in a small pool in a woodlands near Lake Minnetonka. The flowers were few, but germinating seeds and seedlings were found on July 27, 1937.

Wolffia punctata Griseb. with young flowers in a lake along the Minnesota river bottom on July 26, 1937.

Wolffia columbiana Karst. was found associated with *Wolffia punctata* and about as abundant; however, very few of the plants of this species were in flower on July 26. A few days later both species of *Wolffia* were found in flower in the Lake Minnetonka region.

This is the first report of *Wolffia* in flower in the state of Minnesota and may be the first report of this matter for the United States. Material of all these *Lemnaceae* is being collected with the intention of making morphological and cytological studies.

HENRY C. GILBERT
UNIVERSITY OF MINNESOTA

GROWTH IN THE ADULT

SINCE the publication of my study on "Growth During Adult Life,"[1] a number of unexpected letters have reached me with reports of individual experiences in this line. Some of these reports are so interesting and bring to light such curious and novel conditions that I should be thankful for more records of similar nature, particularly by scientific men who are used to precise observation. I therefore appeal to all who in themselves or among their relatives or friends have observed or come to know of accretive normal growth changes in the body or any of its parts during the adult life, to inform me of same. What is desired are as far as possible rigidly accurate data and details, which could reliably be used for further elucidation of the process of normal growth during the adult stage of life.

ALEŠ HRDLIČKA
U. S. NATIONAL MUSEUM
WASHINGTON, D. C.

THE STATEMENT OF THE RUSSIAN PROFESSORS

THE statement recently reprinted in SCIENCE and said to have been signed by many professors of the Russian Academy, may, I think, do injustice to these men. A friend of mine, who not very long ago held a temporary academic position in another European country, was confronted by a document strongly endorsing the policies of that country, intended to be sent to the American press, and requiring only his signature. This he refused to supply, and for a time the resulting situation was annoying and even alarming. Being a distinguished American, he was able to

[1] Proc. Amer. Philos. Soc., 1936, LXXVI, 847–897.

[2] L. E. Noland, *Ecology*, 6: 437, 1925.
[3] Chia Chi Wang, *Jour. Morph.*, 46: 431, 1928.

maintain his position without any serious consequences, but had he been a citizen of the country, one can readily imagine what might have happened.

Now I am quite sure that none of the Russian scientific men have any interest in promoting plots alleged to have originated with Trotsky, but on the other hand, they would not willingly sign such an intemperate and ill-considered paper as that reprinted in SCIENCE. I infer that they signed under compulsion, or possibly that their names were appended without their consent. The paper should not be taken too seriously. The use of intemperate language is not confined to Russia; there are people in all countries who imagine that a grossly exaggerated and distorted statement will be more convincing than a fair presentation of the facts.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

SOCIETIES AND MEETINGS

SUMMER BOTANICAL MEETINGS

THE first of the joint summer meetings of the Botanical Society of America and the American Society of Plant Taxonomists was held at Acadia University, Wolfville, N. S., from August 18 to 20. Sixty-one members of the societies and guests were registered. The meetings were begun by a formal program in the Biology Building of the university on the evening of August 18, Dr. L. C. Petry, vice-president of the Botanical Society of America, presiding. Addresses were as follows: President F. W. Patterson, of Acadia University; the Honorable John A. McDonald, minister of agriculture of the provincial government; Professor Edmund W. Sinnott, president of the Botanical Society of America, and Dr. H. A. Gleason, president of the American Society of Plant Taxonomists.

After inspection of the botanical laboratories on Thursday morning, the Dominion Experimental Station at Kentville was visited under the guidance of Director W. S. Blair. A picnic lunch was served on the station grounds, and the party returned to Wolfville to study the dike lands adjacent to the Minas Basin shore. Particular attention was given to an area about which the dike has broken and in which typical salt marsh vegetation is rapidly being reestablished. This was followed by a visit to the sunken forest northeast of Grand Pré, where firmly rooted stumps are abundant on the tide flats at various levels down to 35 feet below high-tide line.

On Friday the party visited the barrens near Auburn and an extensive raised bog near Aylesford. From that point the route of the party lay through the finest section of the Cornwallis Valley apple district and over North Mountain to Hall's Harbor on the Bay of Fundy. After lunch there, the marine algae of the tide pools were studied under the guidance of Dr. Hugh Bell. Some members of the party then returned to Wolfville and spent the remainder of the day collecting fossil plants of lower Carboniferous age at Horton Bluff. The remainder collected seaside plants along the shore at Hall's Harbor and visited a quaking bog at the foot of North Mountain. No trips were scheduled for Saturday.

The local committee in charge of arrangements consisted of Mr. A. E. Roland, Dr. J. F. Hockey and Professors H. C. Perry, J. M. Bayne and Muriel V. Roscoe (*chairman*). The arrangements were well planned and all trips well managed.

The second joint field meeting was held at the Biological Station of the University of Michigan, Douglas Lake, Mich., from August 24 to 27. Registrations numbered thirty-one, but the attendance was much greater, due to the participation by various staff members and graduate students of the station and guests of members. A local committee, consisting of Professors John H. Ehlers (*chairman*), Frank C. Gates, Carl D. LaRue and George E. Nichols, was in charge of the field trips and camp routine. Tuesday afternoon was occupied with a boat trip on Douglas Lake, followed by a trip of inspection of the numerous laboratories. In the evening, Dr. George R. LaRue, director of the station, officially welcomed the group. Responses were made by Dr. H. A. Gleason and Dr. Karl M. Wiegand, representing the Botanical Society of America. The evening was concluded with an illustrated lecture on "The Biological Station and its Environs" by Dr. George R. LaRue. Wednesday trips were made to the shore of Lake Huron, the Straits of Mackinac, Cecil Bay and Wilderness State Park. On Wednesday evening, Professor W. F. Ramsdell, of the School of Forestry and Conservation of the University of Michigan, addressed the group on "Land Utilization Research." Thursday was devoted to visits to bogs and marshes in the vicinity of Little Lake Sixteen, containing a highly sequestered and essentially undisturbed flora of great diversification. The address of the evening, by Mrs. Ynes Mexia, was entitled "Three Thousand Miles up the Amazon." On Friday morning the meetings were concluded with a trip to the jack-pine plains region.

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SPECIAL ARTICLES

OVOVERDIN, A PIGMENT CHEMICALLY RELATED TO VISUAL PURPLE

VISUAL purple, according to the beautiful experiments of George Wald,[1] belongs to the class of carotenoid-proteins.[2] We have studied another representative of these widely distributed conjugated proteins, namely, the green pigment of the egg of the lobster (*Homarus americanus*). The carotenoid component of the pigment, which was first studied by Miss Newbigin[3] in 1897, has recently been shown to be an ester of astacene (4, 5, 4′, 5′-tetraketo-β-carotene) with an as yet unknown organic acid.[4,5] In the egg, this "ovoester" is linked to a protein of albuminoid character. The name *ovoverdin* is hereby proposed for this pigment. The free ovoester is orange-red and its crystals are practically insoluble in water; the chromoproteid ovoverdin is grass-green and readily water soluble.

Solutions of ovoverdin are obtained by crushing the green lobster eggs with sand and subsequent extraction with distilled water. The dark green, turbid solutions are treated with an equal volume of saturated ammonium sulfate solution. Filtration removes oil globules containing carotene and small amounts of globulins. Such partly purified preparations have been used for most of the present experiments because they contain no other pigment besides ovoverdin; and because, when stored in the dark and at low temperatures, they appear to be somewhat more stable than dialysed solutions or more highly purified preparations which may be obtained by repeated salting-out of the pigment by full saturation with ammonium sulfate.

Visual and photoelectric spectrophotometry reveals two absorption bands in the visible, centering around 6400 and 4700 A. The isoelectric point was found by cataphoresis to be in the vicinity of pH 6.7, close to the isoelectric point of hemoglobin. The rate of sedimentation in the field of the ultracentrifuge (see the following note by Dr. Wyckoff) indicates a molecular weight of the order of 300,000. According to rough calculations one molecule of the pigment appears to contain one molecule of astacene ester.

Alcohol, acetone, chloroform, pyridine, benzol, dioxane, but not petrol ether, liberate rapidly the orange ovoester from the green pigment. The protein is coagulated by this treatment. The pH-stability range of ovoverdin extends from about pH 4 to 8. Acids, *e.g.*, acetic acid, and alkali destroy the complex and liberate the orange-colored carotenoid. Ovoverdin is comparatively stable against dilute but not against concentrated ammonia. The pigment is much more light stable than visual purple. However, solutions of ovoverdin or films prepared with the aid of gelatin bleach to a straw yellow shade when exposed to diffuse daylight for one or two days at room temperature. Lactoflavin accelerates the bleaching process. The solutions of the ovoester in organic solvents fade even more quickly and yield colorless decomposition products which, in contrast to those of retinene, the carotenoid part of visual purple, give no positive Carr-Price test for vitamin A.

The most remarkable property of ovoverdin so far observed is that of *reversible thermal dissociation*. When the pigment solutions are rapidly heated to from 65° to 70° the color turns from grass green to bright orange-red. The absorption spectrum of the red form shows an increased extinction at 4800 A. and an almost complete abolition of the band of ovoverdin in the red, around 6400 A. Upon rapid cooling the green color reappears. This phenomenon is observed only in the presence of neutral salts. If the pigment is exposed to heat for longer periods the color change to red is no longer reversed by cooling. If the temperature is allowed to reach 80° to 100°, a turbidity appears and eventually an orange-pink protein coagulum is formed. These observations are interpreted as follows: The first step consists in a reversible dissociation of the chromoproteid into the ovoester and the free protein carrier. The ovoester may form a colloidal solution. In the second stage the protein is denatured by heat and thereby rendered incapable of recombining with the carotenoid upon cooling. The final stage consists in the coagulation of the denatured protein and adsorption of the ovoester by the precipitate.

The reversible and irreversible heat dissociation may also be observed with intact lobster eggs.

It has been suggested[1,6] that the bleaching of visual purple to visual yellow by light represents a disruption of the carotenoid-protein complex with liberation of the orange-colored carotenoid, retinene. It is assumed that this is due to a denaturation of the protein by light. However, when the energy of heat inactivation of visual purple of about 75,000 cal./mol. is compared with the energy content of the light at the effective wave-lengths, beginning at 5300 A. (53,000

[1] G. Wald, *Jour. Gen. Physiol.*, 19: 351, 1935–36.

[2] Literature in L. S. Palmer, "Carotenoids and Related Pigments," Chem. Catalog Co., New York, 1922.

[3] M. I. Newbigin, *Jour. Physiol.*, 21: 237, 1897.

[4] R. Kuhn and E. Lederer, *Ber. Deutsch. Chem. Ges.*, 66: 488, 1933.

[5] P. Karrer, L. Loewe and H. Huebner, *Helv. Chim. Acta*, 18: 96, 1935.

[6] A. E. Mirsky, *Proc. Nat. Acad. Sci.* (Washington), 22: 147, 1936.

cal. per quantum) there remains a deficit between the energy required for denaturation and the energy actually available.

The present observations would suggest that the primary step in the bleaching process of visual purple is not a denaturation of the protein carrier but perhaps a photodissociation of the type of the reversible thermal dissociation of ovoverdin. Such a conception would account for the rapidity of regeneration of visual purple under physiological conditions; at the same time, it would help to understand why the visual cycle proceeds at an energy level below that of protein denaturation.

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THE SEDIMENTATION CONSTANT OF OVOVERDIN

THROUGH the courtesy of Dr. K. G. Stern and Dr. K. Salomon and with their help, preliminary ultracentrifugal studies have been made of rates of molecular sedimentation in ovoverdin solutions prepared from lobster eggs according to the method described in the preceding note.[1] Several points of interest concerning the degree of purity of such solutions and the order of molecular size and homogeneity of the pigmented protein they contain are brought out in this way.

These studies of sedimentation rates are based on series of photographs made with an analytical air-driven ultracentrifuge[2] arranged for measurements according to the original absorption method of Svedberg. Exploratory examination of a solution of the protein in half-saturated ammonium sulfate indicated the presence of a homogeneous protein so light that it should be sedimented from a solvent of lower density. All subsequent measurements were accordingly made, using as starting material a solution freshly dialyzed to remove all but a trace of the ammonium sulfate.

The pigmented solutions of ovoverdin are dark green in color. They show[1] a very strong light absorption in the blue and violet and an appreciable absorption in the yellow; besides this they have the usual protein ultra-violet absorption of wave-lengths below ca 2800A. Series of sedimentation photographs have been made with blue light and with ultra-violet light shorter than 2700A; simultaneous visual observations were made with yellow light. A photograph with blue light is reproduced in Fig. 1; the second figure is one of the ultra-violet series. In order to have sufficient absorption in the blue, a four millimeter thick cell was used with a solution containing ca 22 milligrams of protein per cc. The sedimentation constant calculated from the diagram of such a solution (Fig. 1) was $s_{20°} = 10.3 \times 10^{-13}$ cm sec^{-1} dynes^{-1}. This solution is far too concentrated to give optimum results with ultra-violet illumination, but a series of photographs made with prolonged exposures showed boundaries yielding the same sedimentation constant—$s_{20°} = 10.4$. It is thus apparent that the blue-absorbing molecules sediment at the same rate as those that absorb in the extreme ultra-violet; from the visual observations it is clear that the substance responsible for the absorption in the yellow comes down at substantially the same rate. These results suggest that the yellow and blue absorptions are due to the same pigment and that this pigment forms part of the protein which presumably is responsible for the ultra-violet boundary.

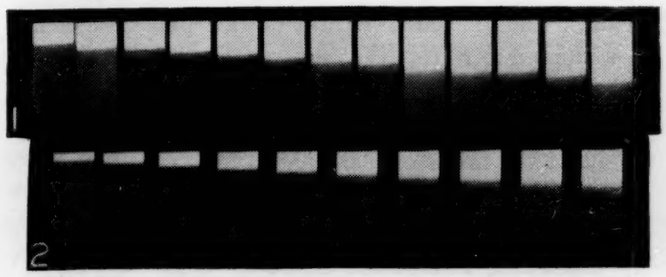

FIG. 1. Sedimentation photographs of ovoverdin using blue light. Source—high pressure mercury arc. Filter—Jena BG 12. Photographic film—Agfa Process. Centrifugal field—ca 90,000 g. Interval between photographs—5 minutes. Exposure—ca ½ second. Fig. 2. A series of sedimentation photographs of ovoverdin, using ultra-violet light. Source—high pressure mercury arc. Filter—chlorine plus bromine cells. Centrifugal field—ca 90,000 g. Interval between photographs—5 minutes. Exposure 1.5 seconds.

Besides this pigmented substance furnishing the boundary with $s_{20°} = 10.3$, these solutions contain an appreciable amount of "unsedimentable" material transparent to visible light but showing a marked ultra-violet absorption. This impurity is not sedimented in the centrifugal fields that have been used. It must therefore be lighter than egg albumin. If it is a protein the viscosity of its solution could be great enough to retard the sedimentation of the large pigmented molecules. This possibility was tested by making sedimentation pictures of the original protein solution after dilution with two parts of water and with eight parts of physiological saline. The slightly higher values of $s_{20°}$ thus obtained—ca 10.8—are probably very near the true sedimentation constant for ovo-

[1] K. G. Stern and K. Salomon, SCIENCE, current issue.
[2] J. Biscoe, E. G. Pickels and R. W. G. Wyckoff, *Jour. Exp. Med.*, 64: 39, 1936; R. W. G. Wyckoff and J. B. Lagsdin, *Rev. Sci. Instr.*, 8: 74, 1937.

verdin. The molecular weight of this protein can not be calculated until its diffusion constant has been determined; but the results of Svedberg[3] indicate that a protein with $s_{20°} = 11$ will probably have a molecular weight of the order of 300,000.

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A BIO-ELECTRIC RECORD OF HUMAN OVULATION[1]

THROUGH the cooperation of a patient in whom a laparotomy was indicated, it has been possible to obtain a continuous graphic record of a voltage difference existing between the symphysis pubis and the vagina for 57 hours. This period included within its limits a predicted time of ovulation based upon day to day observations of the preceding four months.

At noon on July 24, the vagina was negative to the symphysis about ten millivolts. During the next seven hours the vagina gradually became positive until at 7 o'clock it reached thirty millivolts. At 7:05 the recorder was thrown clear off scale, but when the zero point was shifted the voltage record registered between seventy and eighty millivolts. During the next twenty-five minutes this steadily declined until at 7:35 the voltage difference was thirty millivolts, with the vagina still positive. This condition continued until midnight, when the experiment was terminated in order that the patient might obtain a night's rest. At 9:30 A.M., July 25, a laparotomy was done, the ovaries examined and in the left ovary the bright punctate hemorrhage of a recently ruptured follicle was found. Fortunately, this was located at one pole of the ovary. It was resected and immediately fixed in Zenkers.

This observation confirms and extends the studies of Burr, Hill and Allen,[2] Greulich and Hill,[3] and Reboul, Friedgood and Davis.[4] Moreover, it is clear that the use of the Burr-Lane-Nims technique enables one to determine with certainty and accuracy the time of ovulation in an intact human being. A complete account of the observations will be published elsewhere.

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[3] T. Svedberg, *Chem. Rev.*, 20: 81, 1937.

[1] From the Departments of Neuro-Anatomy and Obstetrics and Gynecology, Yale University School of Medicine, aided by grants from the Josiah Macy, Jr., Foundation and the Clinical Fund of the School of Medicine.

[2] H. S. Burr, R. T. Hill and Edgar Allen, *Proc. Soc. Exp. Biol. and Med.*, 33: 109, 1935.

[3] W. W. Greulich and R. T. Hill, personal communication.

[4] J. Reboul, H. B. Friedgood and H. Davis, *Am. Jour. Physiol.*, 119 (2): *Proc. Am. Physiol. Soc.*, 387, 1937.

THE LIFE CYCLE OF MONIEZIA EXPANSA

OVER one hundred species of anoplocephaline cestodes have been described from mammals, birds and reptiles. They are common in herbivorous animals and occur infrequently in man. The development of these tapeworms has been studied repeatedly for the last fifty years. It is noteworthy that, despite their prevalence, wide distribution and economic importance and despite the attempts of numerous investigators to discover the life history, the developmental cycle of these tapeworms has remained an unsolved mystery. The strobilate, sexually mature stage of the cestodes occurs in the intestine, and eggs of the parasite are voided with the feces of the host, but the course of subsequent development and manner by which the final host is reinfected have been entirely unknown. Stunkard[1] has reviewed previous studies on the life cycle of anoplocephaline cestodes and reported experiments, carried on during 1931–1933, which demonstrated that direct infection is impossible and that an intermediate host is necessary for the completion of the life history. The statement was made that the information then available was sufficient to indicate the character of these hosts with much assurance. The bionomic features of the intermediate hosts of this family of cestodes were clearly delineated.

Since 1933 various minute terrestrial invertebrates, chiefly insects, have been used in experiments to determine the life history of the anoplocephaline tapeworms. In the spring of 1936, it was discovered that free living mites would eat the cestode eggs, that the onchospheres would hatch in the intestine and migrate to the body cavity of the mite. In the succeeding months, various tyroglyphid and oribatid mites have been exposed to infection. *Moniezia expansa* is one of the most common and important of these cestodes. Eggs of *M. expansa* were fed to specimens of *Galumna* sp. and the onchospheres recovered in large numbers from the body cavity. Since this mite appeared to be a likely intermediate host, it was used extensively. Thousands of specimens have been exposed during the past year and dissected at various intervals after feeding on *Moniezia* eggs. In this way a series of developmental stages, from the onchosphere to the infective cysticercoid, have been recovered from the body cavity of *Galumna* sp. These results demonstrate the correctness of the conclusions expressed in the paper by Stunkard (1934). The discovery of the life history of *Moniezia expansa* solves the problem of the life cycle among anoplocephaline cestodes. A more complete description of the larval stages will be published elsewhere.

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[1] *Zeitschrift für Parasitenkunde*, 6: pp. 481–507, 1934.

CARBOHYDRATE ACCUMULATION IN RELATION TO VEGETATIVE PROPAGATION OF THE LITCHI[1]

THE most satisfactory method of propagating many woody plants vegetatively is by grafting. In temperate regions, grafting is usually done in the late winter or early spring when the plant has passed through a dormant period, is well stocked with food reserves,[2] and the plant is ready to make its annual increment of growth. In Hawaii, however, there is no apparent dormant season in the litchi and little consequent accumulation of reserves. Starch, the principal carbohydrate storage form in the litchi, rarely accumulates to greater than .4 to .5 per cent. of the dry weight of non-flowering branches. The small amounts that do accumulate are quickly utilized in making a new flush of growth.

The usual method of propagating the litchi in China is by means of air-layering, which may be considered a form of cuttage. The treatment, *i.e.*, the removal of a ring of bark, is such that carbohydrates accumulate and roots are produced in a suitable container before removal from the tree. Mitchell[3] and Reid[4] have shown the importance of carbohydrates in the rooting of tomato cuttings, while little attention has been given to their importance in vegetative propagation by grafting. For many years, attempts have been made to graft the litchi, without regard to the carbohydrate storage, with very little success. By using scions high in starch we have increased the percentage of successful grafts from 10 per cent. as reported by Pope[5] to 75 and 80 per cent. Carbohydrates are caused to accumulate in the scion by removing a small ring of bark about one eighth inch wide from the branch, to be used three to four weeks later as scionwood. This branch should be about one half to three fourths inch in diameter. Table 1 shows the composition of the scionwood before and three weeks after girdling.

TABLE 1

EFFECT OF GIRDLING ON CARBOHYDRATE ACCUMULATION IN LITCHI (LITCHI CHINENSIS)

Per cent. dry weight	Girdled branch	Non-girdled branch
Starch	11.40	0.40
Total sugar	2.10	1.68
Protein nitrogen ..	1.14	1.16
Soluble nitrogen ...	0.10	0.12

This principle is also being applied successfully in propagating the macadamia (*Macadamia ternifolia*), which formerly was considered almost impossible to propagate by grafting. The main purpose of this note is to again call attention to the importance of food reserves in vegetative propagation. Table 1 shows that there was very little change in the nitrogen and sugars in the girdled branches as compared to the non-girdled, but that there was about a 28-fold increase in starch.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

"AIR CONDITIONING" FOR MICROTOMES

HOT weather has always offered a serious handicap to the cutting of tissues embedded in paraffin. In many places this difficulty is experienced from June to November or even longer. It is therefore with a great deal of satisfaction that I can present here a method for cooling the microtome and tissue that takes but a few minutes to put into operation, is inexpensive to operate and is superior in cleanliness and effectiveness to the variety of devices already suggested.

Select a strong corrugated cardboard box with a cross-section approximately 12 × 12 inches and a length of about 18 inches. Lay it on one side with the top toward you. Leave the top flaps intact. Place the microtome in the box. Cut a rectangular window about 2½ × 4 inches in the box just above the object block of the microtome. Obtain a pound coffee tin or one of similar dimensions and punch a few holes in the bottom and top. Insulate the tin by wrapping it in any good insulating material. Insulating felt is preferable, although a sufficient swathing of newspapers will do. Leave top and bottom of the tin exposed. Put one or two pounds of dry ice in the tin. Place the tin over the rectangular window on top of the cardboard box. A down draught of air is carried over the dry ice through the holes in the bottom of the can and from there the cold streams of air drift downward over the object mounted in paraffin, over the knife and over the microtome as a whole. When the lid flaps are closed the temperature inside of the box soon falls to six or eight degrees below room temperature.

With the paraffin block, knife and microtome at practically the same temperature, sections cut readily and adhere to form perfect ribbons. When the lid

[1] Published with the approval of the Director, Hawaii Agricultural Experiment Station.

[2] A. E. Murneek, *Proc. Amer. Soc. Hort. Sci.*, 30: 319–321, 1933.

[3] John W. Mitchell, *Plant Physiol.*, 11: 833–841, 1936.

[4] Mary E. Reid, *Amer. Jour. Bot.*, 13: 548–574, 1926.

[5] W. T. Pope and William B. Storey, Hawaii Agr. Expt. Sta. Circ. No. 6, 1933.

flaps are opened the streams of cold air continue to fall on the knife and paraffin block so that no serious change of temperature takes place.

In a box of the size mentioned no difficulty is experienced in turning the wheel of a rotary microtome, although it is not easy to adjust the paraffin block to proper cutting position. This can be accomplished by sliding the microtome out of the box to make the adjustments. A better method is to remove the floor of the box so that the microtome can stand on the table. In the latter case the entire box can be pushed back to expose the microtome.

Should the tissue and paraffin become too cold push the dry ice container away from the window until the proper temperature conditions are reestablished. Two pounds of dry ice costing ten cents will adequately "air condition" a microtome for five or six hours.

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A METHOD FOR STUDYING ENVIRONMENTAL CHOICES OF LABORATORY ANIMALS

A PIECE of research on the white-footed mouse, *Peromyscus leucopus noveboracensis,* demanded a study of the activity of the animals during periods of light and darkness. It was also necessary to determine how much time an animal spent in the light when it was free to make a choice between the two environmental factors. The apparatus to be described records such information continuously for as long as ten days if desired. It is hoped that other workers may find the method useful as adapted to their particular problems.

A two-compartment cage of a size suitable for the animal under investigation was constructed of light wire. (See the accompanying illustration.) One compartment, D, is made light tight and is connected by a tunnel, T, to the other, O, which is left uncovered, open to the environmental condition of light. Nesting material, food and water may be assigned to the two portions of the cage as seen advisable.

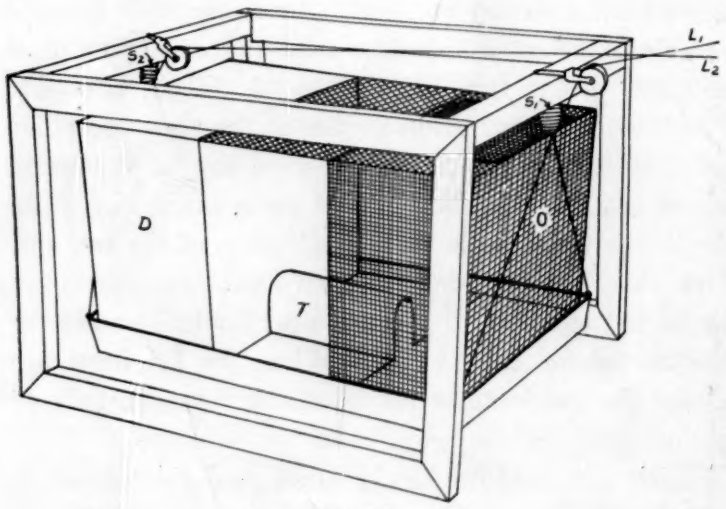

FIG. 1.

The cage is suspended to a suitable support by springs, S_1 and S_2. When the animal is active the cage moves up and down. When the weight of the animal is moved to one compartment the corresponding end of the cage is depressed, while the other is elevated. This shift may be exaggerated by moving the attachments of the two springs nearer to each other. Threads L_1 and L_2, connected with the ends of the cage and running through suitable pulleys, are attached to light heart levers on a ring stand. The levers make contact one above the other with the smoked paper of a slow moving kymograph. Movements of the animal are registered by both levers. If the upper lever is actuated by L_1 from the front end of the cage there is a spreading of the lines of the record when the animal is in front, O, whereas the lines approach each other when it is in the back compartment, D. An interval marker (alarm clock making electrical contact by either hand at twelve o'clock) leaves a time record every hour and a special mark at noon and midnight. A record of time and duration of the illumination of the unit is added by hand. Examination of the fixed paper reveals the time of activity and the position of the animal relative to light and darkness at any time during the experiment.

This method might be applied to various studies of animals heavy enough to move light heart levers in suitably constructed cages, except fish and others which must live in water continuously. That is, the choice an animal makes between two different environments which can be maintained in one cage can be determined and readily studied. For example, temperature choices of frogs, light choices of snails or moisture choices of certain insects might be recorded.

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